19-1516; Rev 0; 7/99

2.5Ω, Quad, SPST, CMOS Analog Switches

General Description

The MAX4661/MAX4662/MAX4663 quad analog switches feature low on-resistance of 2.5Ω max. On-resistance is matched between switches to 0.5Ω max and is flat (0.5Ω max) over the specified signal range. Each switch can handle Rail-to-Rail® analog signals. Off-leakage current is only 5nA max at T_A = +85°C. These analog switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automatic test equipment or applications where current switching is required. They have lower power requirements, use less board space, and are more reliable than mechanical relays.

The MAX4661 has four normally closed (NC) switches, and the MAX4662 has four normally open (NO) switches. The MAX4663 has two NC and two NO switches, and features guaranteed break-before-make switching.

These devices operate from a single +4.5V to +36V supply or from dual ±4.5V to ±20V supplies. A separate logic supply pin guarantees TTL/CMOS-logic compatibility when operating across the entire supply voltage range.

Applications

- Reed Relay Replacement
- Test Equipment
- Communication Systems
- PBX, PABX Systems
- Audio-Signal Routing
- Avionics
- ADC Systems
- Sample-and-Hold Circuits
- Data Acquisition Systems

Features

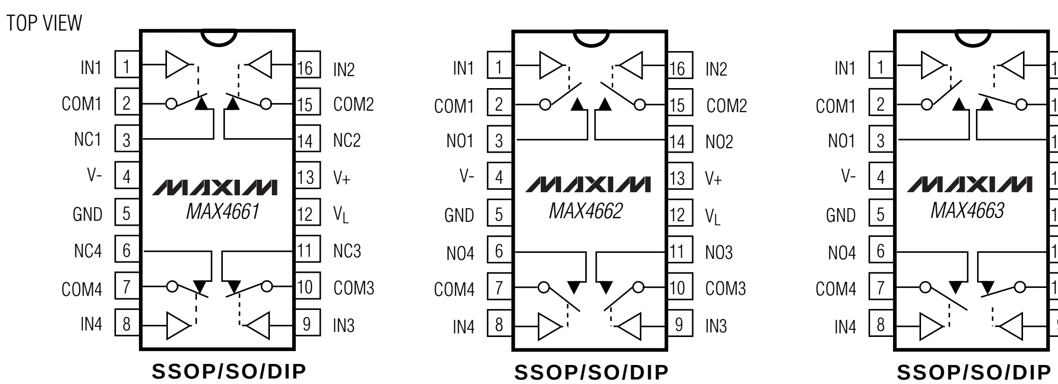
- ♦ **Low On-Resistance (2.5Ω max)**
- ♦ **Guaranteed R_{ON} Match Between Channels (0.5Ω max)**
- ♦ **Guaranteed R_{ON} Flatness over Specified Signal Range (0.5Ω max)**
- ♦ **Rail-to-Rail Signal Handling**
- ♦ **Guaranteed Break-Before-Make (MAX4663)**
- ♦ **> 2kV ESD Protection per Method 3015.7**
- ♦ **+4.5V to +36V Single-Supply Operation ±4.5V to ±20V Dual-Supply Operation**
- ♦ **TTL/CMOS-Compatible Control Inputs**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX4661CAE	0°C to +70°C	16 SSOP
MAX4661CWE	0°C to +70°C	16 Wide SO
MAX4661CPE	0°C to +70°C	16 Plastic DIP
MAX4661EAE	-40°C to +85°C	16 SSOP
MAX4661EWE	-40°C to +85°C	16 Wide SO
MAX4661EPE	-40°C to +85°C	16 Plastic DIP

Ordering Information continued at end of data sheet.

Pin Configurations/Functional Diagrams/Truth Tables



MAX4661	
LOGIC	SWITCH
0	ON
1	OFF

MAX4662	
LOGIC	SWITCH
0	OFF
1	ON

MAX4663		
LOGIC	SWITCHES 1, 4	SWITCHES 2, 3
0	OFF	ON
1	ON	OFF

SWITCHES SHOWN FOR LOGIC "0" INPUT

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

2.5Ω, Quad, SPST, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

V+ to GND ....-0.3V to +44V
V- to GND ....+0.3V to -44V
V+ to V-..-0.3V to +44V
V_L to GND ....(GND - 0.3V) to (V+ + 0.3V)
All Other Pins to GND (Note 1) ....(V- - 0.3V) to (V+ + 0.3V)
Continuous Current (COM_, NO_, NC_) ....±200mA
Peak Current (COM_, NO_, NC_)
(pulsed at 1ms, 10% duty cycle)................................ ±300mA

Continuous Power Dissipation (T_A = +70°C)
SSOP (derate 7.1mW/°C above +70°C) 571mW
Wide SO (derate 9.52mW/°C above +70°C).................762mW
Plastic DIP (derate 10.53mW/°C above +70°C) 842mW
Operating Temperature Ranges
MAX466_C_E ....0°C to +70°C
MAX466_E_E ....-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10sec) ....+300°C

Note 1: Signals on NC_, NO_, COM_, or IN_ exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = +15V, V- = -15V, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Input Voltage Range (Note 3)	$V_{COM_}$, $V_{NO_}$, $V_{NC_}$			V-		V+	V
COM_ to NO or NC_ On-Resistance	R_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = ±10V	T_A = +25°C		1.7	2.5	Ω
			T_A = T_{MIN} to T_{MAX}			2.7	
COM_ to NO_ or NC_ On-Resistance Match Between Channels (Notes 3, 4)	ΔR_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$= ±10V	T_A = +25°C		0.1	0.5	Ω
			T_A = T_{MIN} to T_{MAX}			0.6	
COM_ to NO_ or NC_ On-Resistance Flatness (Notes 3, 5)	$R_{FLAT(ON)}$	$I_{COM_}$ = 10mA; $V_{NO_}$ or $V_{NC_}$ = -5V, 0, 5V	T_A = +25°C		0.1	0.5	Ω
			T_A = T_{MIN} to T_{MAX}			0.6	
Off-Leakage Current (NO_ or NC_) (Note 6)	$I_{NO_}$, $I_{NC_}$	$V_{COM_}$ = ±10V, $V_{NO_}$ or $V_{NC_}$= ∓10V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-5		5	
COM Off-Leakage Current (Note 6)	$I_{COM_(OFF)}$	$V_{COM_}$ = ±10V, $V_{NO_}$ or $V_{NC_}$ = ∓10V	T_A = +25°C	-0.5	0.01	0.5	nA
			T_A = T_{MIN} to T_{MAX}	-5		5	
COM On-Leakage Current (Note 6)	$I_{COM_(ON)}$	$V_{COM_}$ = ±10V, $V_{NO_}$ or $V_{NC_}$= ±10V or floating	T_A = +25°C	-1	0.01	1	nA
			T_A = T_{MIN} to T_{MAX}	-20		20	
LOGIC INPUT							
Input Current with Input Voltage High	I_{IN_H}	IN_ = 2.4V, all others = 0.8V		-0.5	0.001	0.5	µA
Input Current with Input Voltage Low	I_{IN_L}	IN_ = 0.8V, all others = 2.4V		-0.5	0.001	0.5	µA
Logic Input Voltage High	V_{IN_H}			2.4			V
Logic Input Voltage Low	V_{IN_L}					0.8	V

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

($V+ = +15V$, $V- = -15V$, $V_L = +5V$, $V_{IN_H} = +2.4V$, $V_{IN_L} = +0.8V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY							
Power-Supply Range				±4.5		±20.0	V
Positive Supply Current	I+	V_{IN} = 0 or 5V	$T_A = +25°C$	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
Negative Supply Current	I-	V_{IN} = 0 or 5V	$T_A = +25°C$	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
Logic Supply Current	I_L	V_{IN} = 0 or 5V	$T_A = +25°C$	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
Ground Current	I_{GND}	V_{IN} = 0 or 5V	$T_A = +25°C$	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time	t_{ON}	$V_{COM_} = ±10V$, Figure 2	$T_A = +25°C$		130	275	ns
			$T_A = T_{MIN}$ to T_{MAX}			400	
Turn-Off Time	t_{OFF}	$V_{COM_} = ±10V$, Figure 2	$T_A = +25°C$		100	175	ns
			$T_A = T_{MIN}$ to T_{MAX}			300	
Break-Before-Make Time (MAX4663 only)	t_{OPEN}	$V_{COM_} = ±10V$, Figure 3, $T_A = +25°C$		5	30		ns
Charge Injection	Q	$C_L = 1.0nF$, $V_{GEN} = 0$, $R_{GEN} = 0$, Figure 4			300		pC
Off-Isolation (Note 7)	V_{ISO}	$R_L = 50\Omega$, $C_L = 5pF$, f = 1MHz, Figure 5			-56		dB
Crosstalk (Note 8)	V_{CT}	$R_L = 50\Omega$, $C_L = 5pF$, f = 1MHz, Figure 6			-59		dB
NC_ or NO_ Capacitance	C_{OFF}	f = 1MHz, Figure 7			55		pF
COM_ Off-Capacitance	C_{COM}	f = 1MHz, Figure 7			55		pF
On-Capacitance	C_{COM}	f = 1MHz, Figure 8			250		pF

2.5Ω, Quad, SPST, CMOS Analog Switches

ELECTRICAL CHARACTERISTICS—Single Supply

($V+ = +12V$, $V- = 0$, $V_L = +5V$, $V_{IN_H} = +2.4V$, $V_{IN_L} = +0.8V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Input Voltage Range (Note 3)	$V_{COM_}$, $V_{NO_}$, $V_{NC_}$			GND		V+	V
COM_ to NO or NC_ On-Resistance	R_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or $V_{NC_}$ = 10V	T_A = +25°C		3	4	Ω
			$T_A = T_{MIN}$ to T_{MAX}			5	
COM_ to NO_ or NC_ On-Resistance Match Between Channels (Notes 3, 4)	ΔR_{ON}	$I_{COM_}$ = 10mA, $V_{NO_}$ or = $V_{NC_}$= 10V	T_A = +25°C		0.03	0.4	Ω
			$T_A = T_{MIN}$ to T_{MAX}			0.5	
COM_ to NO_ or NC_ On-Resistance Flatness (Notes 3, 5)	$R_{FLAT(ON)}$	$I_{COM_}$ = 10mA; $V_{NO_}$ or $V_{NC_}$ = 3V, 6V, 9V	T_A = +25°C		0.1	0.7	Ω
			$T_A = T_{MIN}$ to T_{MAX}			0.8	
Off-Leakage Current (NO_ or NC_) (Notes 6, 9)	$I_{NO_}$ $I_{NC_}$	$V_{COM_}$ = 1V, 10V; $V_{NO_}$ or $V_{NC_}$ = 10V, 1V	T_A = +25°C	-0.5	0.01	0.5	nA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
COM Off-Leakage Current (Notes 6, 9)	$I_{COM_(OFF)}$	$V_{NO_}$ or $V_{NC_}$ = 10V, 1V; $V_{COM_}$ = 1V, 10V	T_A = +25°C	-0.5	0.01	0.5	nA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
COM On-Leakage Current (Notes 6, 9)	$I_{COM_(ON)}$	$V_{COM_}$ = 1V ,10V; $V_{NO_}$ or $V_{NC_}$ = 1V, 10V, or floating	T_A = +25°C	-1	0.01	1	nA
			$T_A = T_{MIN}$ to T_{MAX}	-20		20	
LOGIC INPUT							
Input Current with Input Voltage High	I_{IN_H}	IN_ = 2.4V, all others = 0.8V		-0.5	0.001	0.5	µA
Input Current with Input Voltage Low	I_{IN_L}	IN_ = 0.8V, all others = 2.4V		-0.5	0.001	0.5	µA
Logic Input Voltage High	V_{IN_H}			2.4			V
Logic Input Voltage Low	V_{IN_L}					0.8	V
POWER SUPPLY							
Power-Supply Range				+4.5		+36.0	V
Positive Supply Current	I+	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
Logic Supply Current	I_L	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	
Ground Current	I_{GND}	V_{IN} = 0 or 5V	T_A = +25°C	-0.5	0.001	0.5	µA
			$T_A = T_{MIN}$ to T_{MAX}	-5		5	

ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V+ = +12V, V- = 0, V_L = +5V, V_{IN_H} = +2.4V, V_{IN_L} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
SWITCH DYNAMIC CHARACTERISTICS							
Turn-On Time (Note 3)	t_{ON}	$V_{COM_}$ = 10V, Figure 2	T_A = +25°C		200	400	ns
			T_A = T_{MIN} to T_{MAX}			500	
Turn-Off Time (Note 3)	t_{OFF}	$V_{COM_}$ = 10V, Figure 2	T_A = +25°C		100	250	ns
			T_A = T_{MIN} to T_{MAX}			350	
Break-Before-Make Time (MAX4663 only) (Note 3)	t_{OPEN}	$V_{COM_}$ = 10V, Figure 3, T_A = +25°C		5	125		ns
Charge Injection	Q	C_L = 1.0nF, V_{GEN} = 0, R_{GEN} = 0, Figure 4			20		pC
Crosstalk (Note 8)	V_{CT}	R_L = 50Ω, C_L = 5pF, f = 1MHz, Figure 6			-60		dB
NC_ or NO_ Capacitance	C_{OFF}	f = 1MHz, Figure 7			85		pF
COM Off-Capacitance	C_{COM}	f = 1MHz, Figure 7			85		pF
On-Capacitance	C_{COM}	f = 1MHz, Figure 8			140		pF

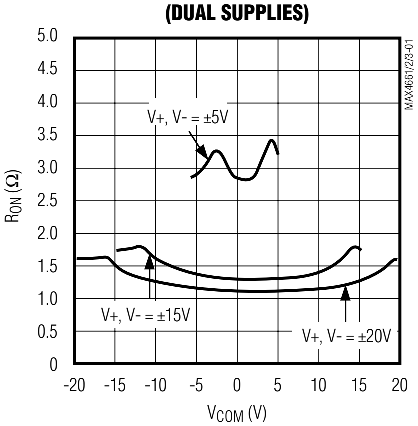
Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.
Note 3: Guaranteed by design.
Note 4: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 5: Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.
Note 6: Leakage parameters are 100% tested at maximum-rated hot temperature and guaranteed by correlation at +25°C.
Note 7: Off-isolation = $20\log_{10} [V_{COM} / (V_{NC} \text{ or } V_{NO})]$, V_{COM} = output, V_{NC} or V_{NO} = input to off switch.
Note 8: Between any two switches.
Note 9: Leakage testing at single supply is guaranteed by testing with dual supplies.

2.5Ω, Quad, SPST, CMOS Analog Switches

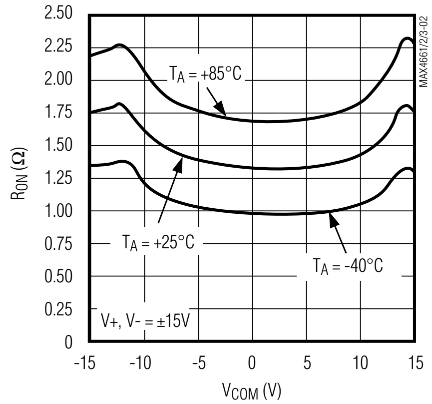
Typical Operating Characteristics

(TA = +25°C, unless otherwise noted.)

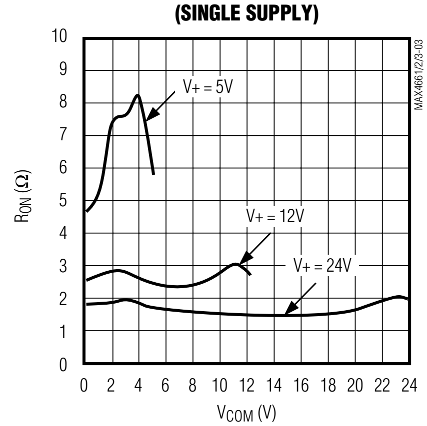
ON-RESISTANCE vs. VCOM (DUAL SUPPLIES)



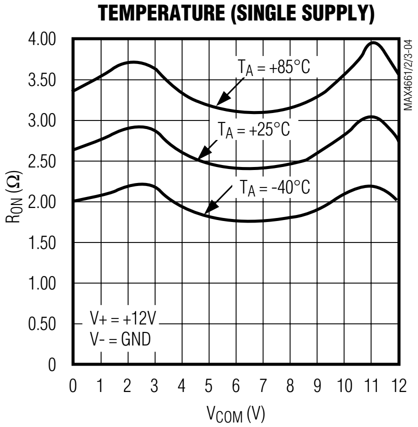
ON-RESISTANCE vs. VCOM AND TEMPERATURE (DUAL SUPPLIES)



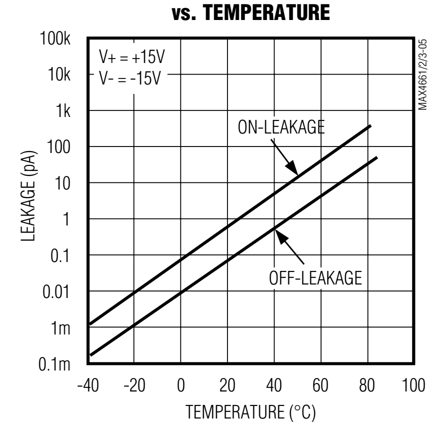
ON-RESISTANCE vs. VCOM (SINGLE SUPPLY)



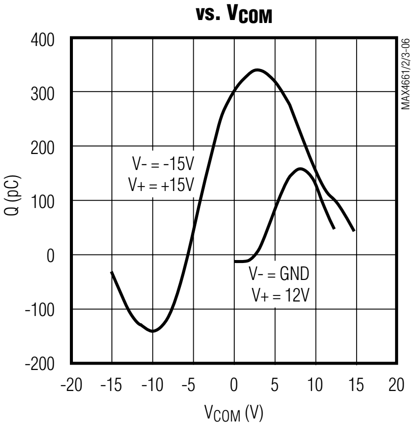
ON-RESISTANCE vs. VCOM AND TEMPERATURE (SINGLE SUPPLY)



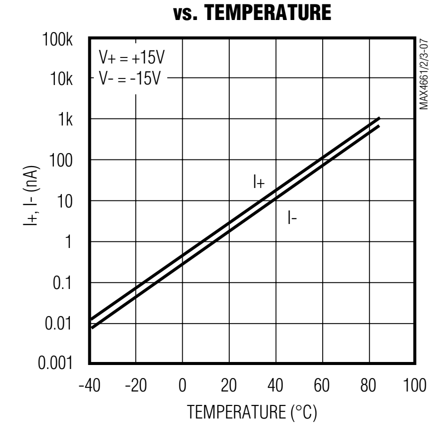
ON/OFF-LEAKAGE CURRENT vs. TEMPERATURE



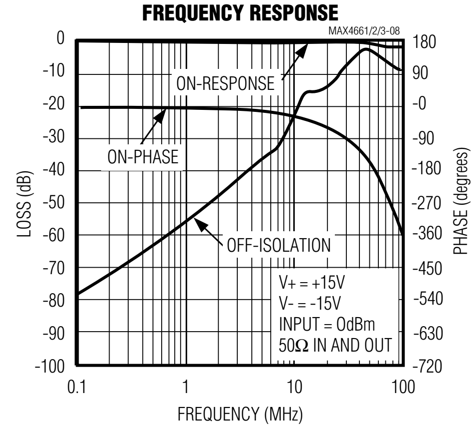
CHARGE INJECTION vs. VCOM



POWER-SUPPLY CURRENT vs. TEMPERATURE



FREQUENCY RESPONSE



Pin Description

PIN			NAME	FUNCTION
MAX4661	MAX4662	MAX4663		
1, 16, 9, 8	1, 16, 9, 8	1, 16, 9, 8	IN1, IN2, IN3, IN4	Logic-Control Digital Inputs
2, 15, 10, 7	2, 15, 10, 7	2, 15, 10, 7	COM1, COM2, COM3, COM4	Analog Switch Common Terminals
3, 14, 11, 6	—	—	NC1, NC2, NC3, NC4	Analog Switch Normally Closed Terminals
—	3, 14, 11, 6	—	NO1, NO2, NO3, NO4	Analog Switch Normally Open Terminals
—	—	3, 6	NO1, NO4	Analog Switch Normally Open Terminals
—	—	14, 11	NC2, NC3	Analog Switch Normally Closed Terminals
4	4	4	V-	Negative Analog Supply-Voltage Input. Connect to GND for single-supply operation.
5	5	5	GND	Ground
12	12	12	V_L	Logic-Supply Input
13	13	13	V+	Positive Analog Supply Input

Applications Information

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs, NO, or COM. If power-supply sequencing is not possible, add two small-signal diodes (D1, D2) in series with the supply pins and a Schottky diode between V+ and V_L for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V.

Off-Isolation at High Frequencies

In 50Ω systems, the high-frequency on-response of these parts extends from DC to above 100MHz with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor and off-isolation decreases with increasing frequency. (Above 300MHz, the switch actually passes more signal turned off than turned on.) This effect is more pronounced with higher source and load impedances.

Above 5MHz, circuit board layout becomes critical and it becomes difficult to characterize the response of the switch independent of the circuit. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors to a circuit board deemed "average"; that is, designed with isolation in mind, but not using stripline or other special RF circuit techniques. For critical applications above 5MHz, use the MAX440, MAX441, and MAX442, which are fully characterized up to 160MHz.

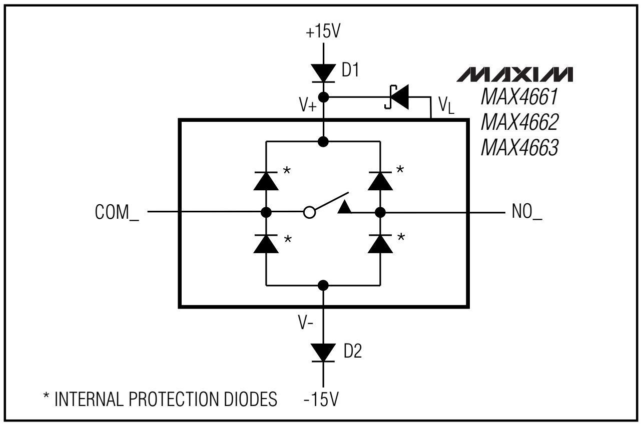


Figure 1. Overvoltage Protection Using External Blocking Diodes

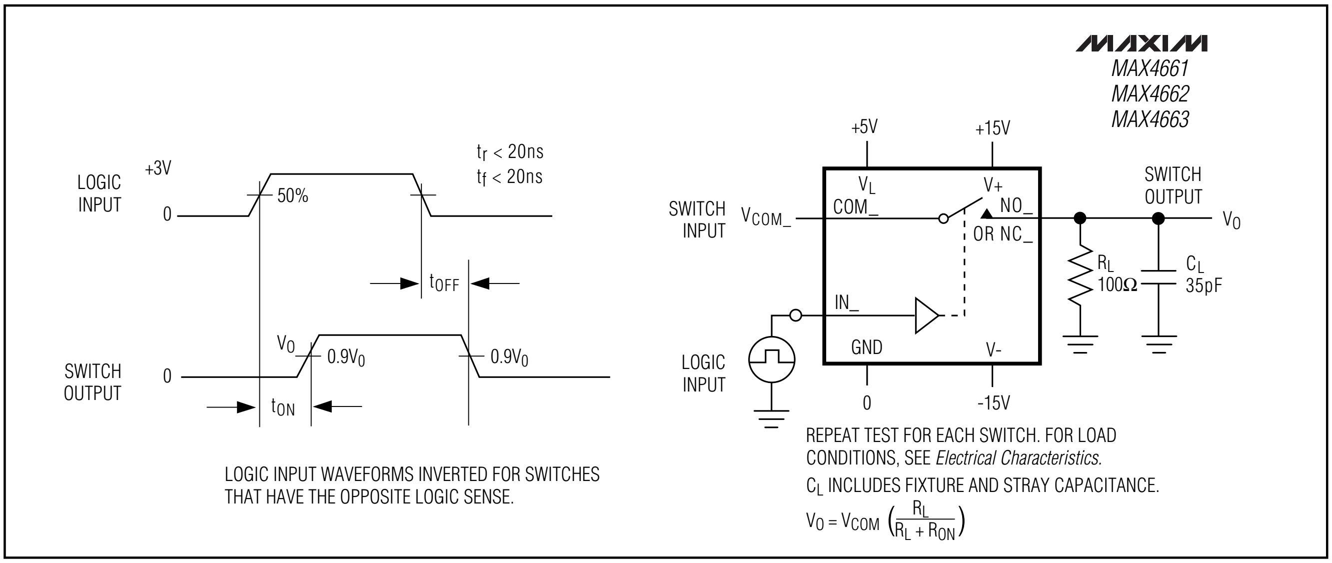


Figure 2. Switching-Time Test Circuit

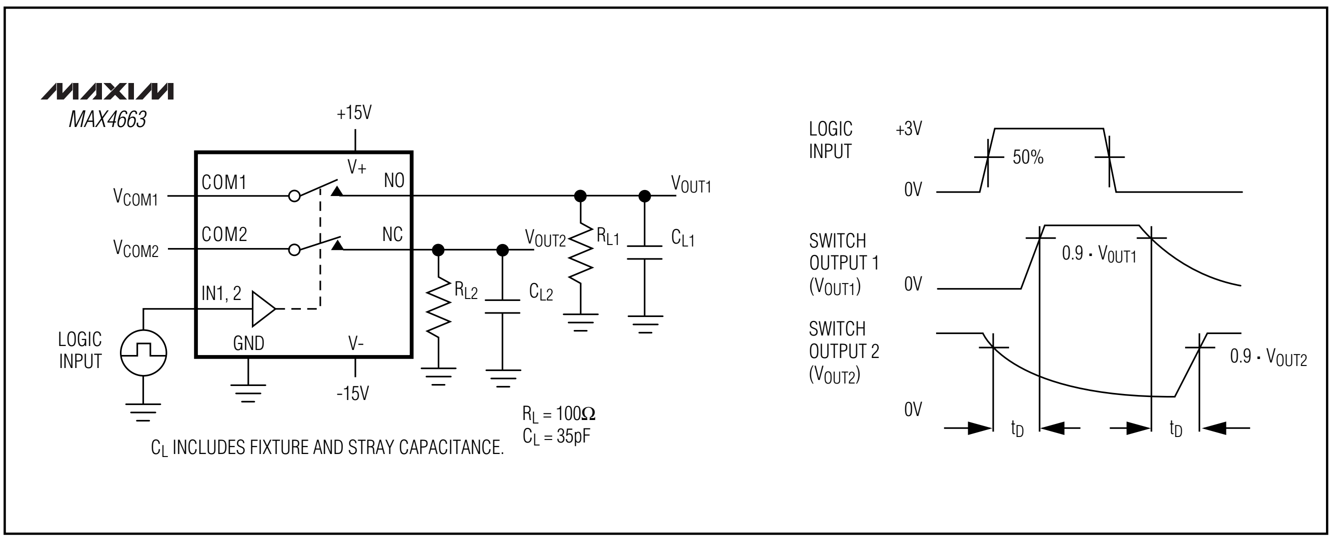


Figure 3. Break-Before-Make Interval (MAX4663 only)

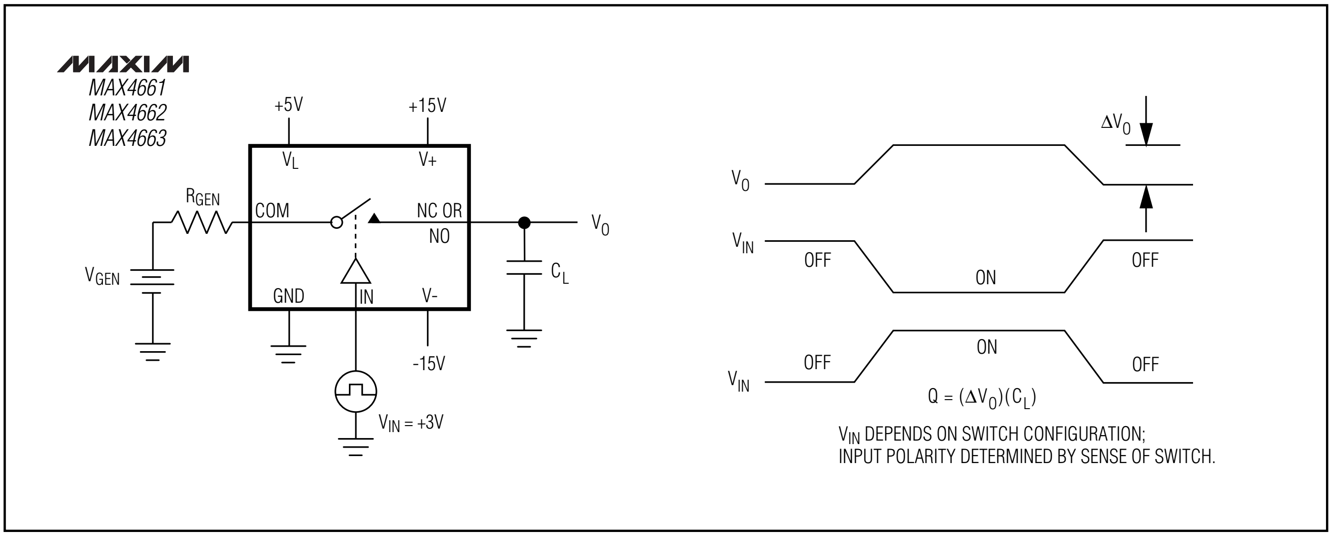


Figure 4. Charge-Injection Test Circuit

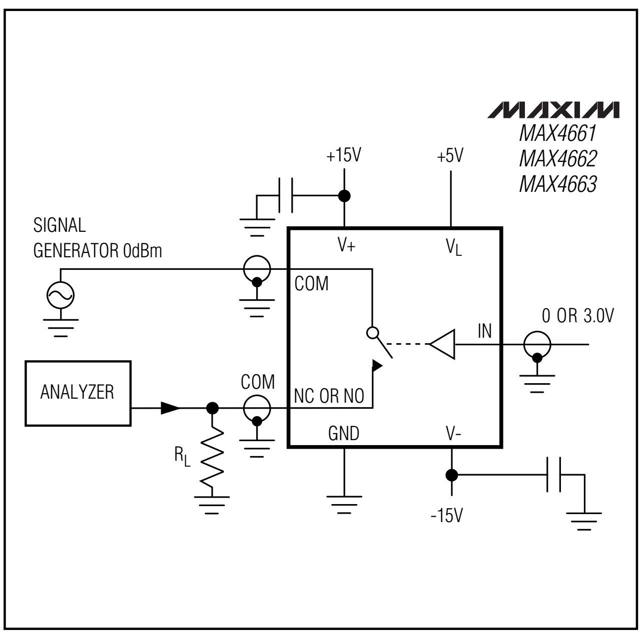


Figure 5. Off-Isolation Test Circuit

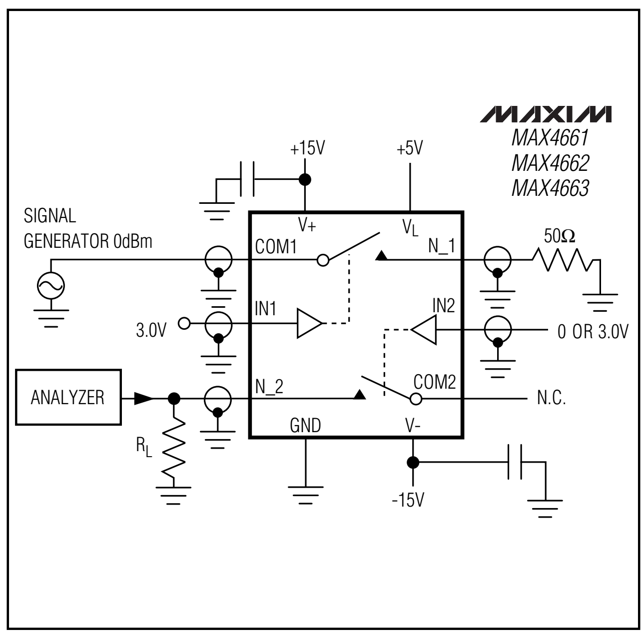


Figure 6. Crosstalk Test Circuit

2.5Ω, Quad, SPST, CMOS Analog Switches

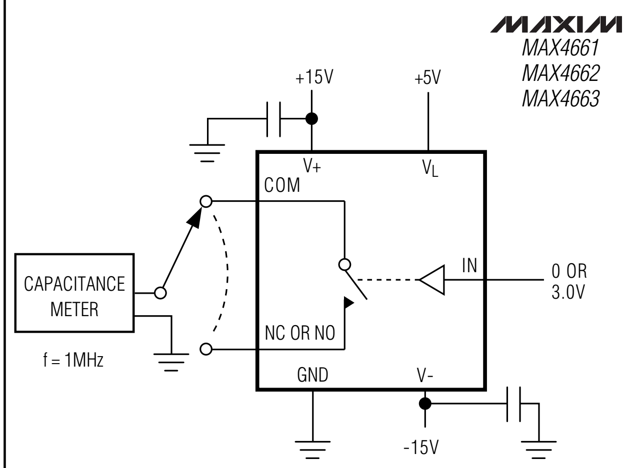


Figure 7. Switch Off-Capacitance Test Circuit

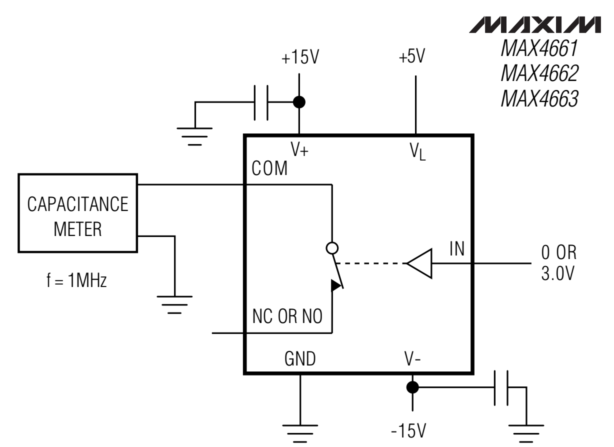


Figure 8. Switch On-Capacitance Test Circuit

Ordering Information (continued)

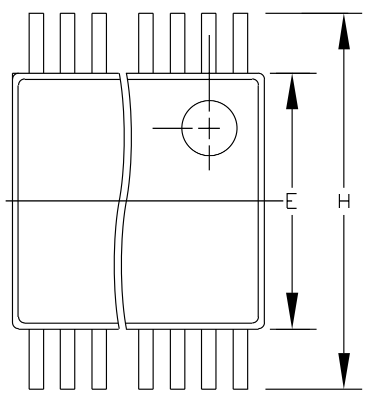
PART	TEMP. RANGE	PIN-PACKAGE
MAX4662CAE	0°C to +70°C	16 SSOP
MAX4662CWE	0°C to +70°C	16 Wide SO
MAX4662CPE	0°C to +70°C	16 Plastic DIP
MAX4662EAE	-40°C to +85°C	16 SSOP
MAX4662EWE	-40°C to +85°C	16 Wide SO
MAX4662EPE	-40°C to +85°C	16 Plastic DIP
MAX4663CAE	0°C to +70°C	16 SSOP
MAX4663CWE	0°C to +70°C	16 Wide SO
MAX4663CPE	0°C to +70°C	16 Plastic DIP
MAX4663EAE	-40°C to +85°C	16 SSOP
MAX4663EWE	-40°C to +85°C	16 Wide SO
MAX4663EPE	-40°C to +85°C	16 Plastic DIP

Chip Information

TRANSISTOR COUNT: 108

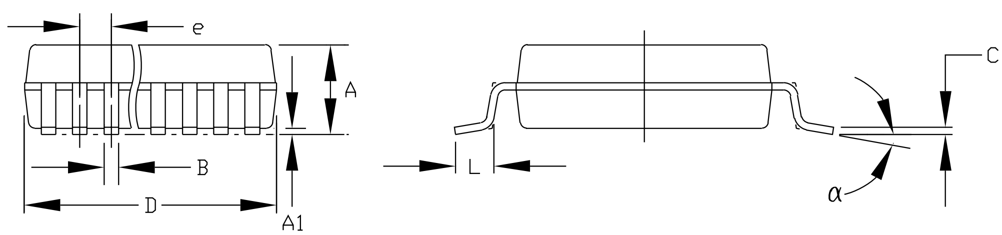
Package Information

SSOP.EPS



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.068	0.078	1.73	1.99
A1	0.002	0.008	0.05	0.21
B	0.010	0.015	0.25	0.38
C	0.004	0.008	0.09	0.20
D	SEE VARIATIONS			
E	0.205	0.209	5.20	5.38
e	0.0256 BSC		0.65 BSC	
H	0.301	0.311	7.65	7.90
L	0.025	0.037	0.63	0.95
α	0°	8°	0°	8°

	INCHES		MILLIMETERS		
	MIN	MAX	MIN	MAX	
D	0.239	0.249	6.07	6.33	14L
D	0.239	0.249	6.07	6.33	16L
D	0.278	0.289	7.07	7.33	20L
D	0.317	0.328	8.07	8.33	24L
D	0.397	0.407	10.07	10.33	28L

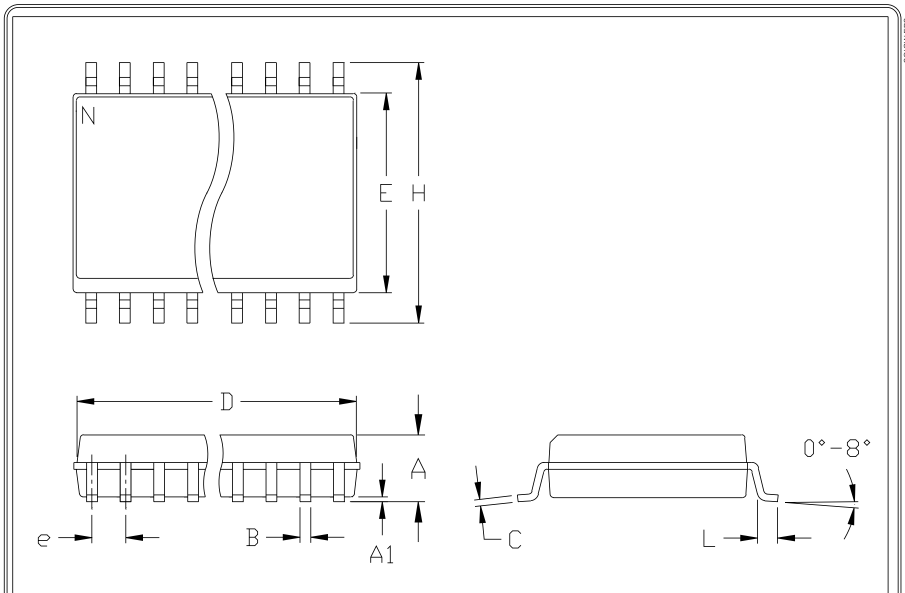


NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER

MAXIM
PROPRIETARY INFORMATION
TITLE:
PACKAGE OUTLINE, SSOP, 5.3X.65mm

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0056	A	1/1

Package Information (continued)



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.093	0.104	2.35	2.65
A1	0.004	0.012	0.10	0.30
B	0.014	0.019	0.35	0.49
C	0.009	0.013	0.23	0.32
e	0.050		1.27	
E	0.291	0.299	7.40	7.60
H	0.394	0.419	10.00	10.65
h	0.010	0.030	0.25	0.75
L	0.016	0.050	0.40	1.27

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS013
D	0.398	0.413	10.10	10.50	16	AA
D	0.447	0.463	11.35	11.75	18	AB
D	0.496	0.512	12.60	13.00	20	AC
D	0.598	0.614	15.20	15.60	24	AD
D	0.697	0.713	17.70	18.10	28	AE

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
4. CONTROLLING DIMENSION: MILLIMETER
5. MEETS JEDEC MS013-XX AS SHOWN IN ABOVE TABLE
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR. SUNNYVALE CA 94086 FAX (408) 737 7194 PROPRIETARY INFORMATION | TITLE: PACKAGE FAMILY OUTLINE: SOIC .300" | 1/1 | 21-0042 A DOCUMENT CONTROL NUMBER REV

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